



# VALENCE

ELECTRICAL TRAINING SERVICES

Do you want to be a  
better relay tester?



# About Valence Electrical Training Services

## About Our Relay Training Center

Most protective relay training falls into three categories:

- Engineering books written for design engineers, not relay testers.
- Courses hosted by relay manufacturers specific to their relays.
- Test-set manufacturer, or automated test software, training focused on how to get their solution to test the relay with minimum user input.

### *We believe that:*

- The power system is universal, and you can apply the same principles to any relay model or manufacturer
- All modern test-sets can test any modern relay.
- A skilled relay tester will always test a relay more effectively and efficiently than a button pusher, while fixing problems the alternatives will never discover.

### *All of our relay training material:*

- Is written specifically for relay testers in plain language.
- Is designed to be universal and can be applied to any relay or any test-set.
- Includes the theory necessary to understand what is happening inside the relay, and why.
- Has universal, step-by-step procedures so the relay tester knows how to apply the theory.
- Uses the most efficient and effective relay testing techniques used today.

## The Relay Testing Handbook Series

**Valence Electrical Training Services** started with a paper presented at a major electrical testing conference that turned into *The Relay Testing Handbook* series, a comprehensive series of nine books, each of which covers a specific relay testing topic. Any technician who has ever been faced with a confusing or challenging situation in the field will appreciate that a relay tester, not an engineer, wrote these books. This practical resource gives you the tools you need to test almost any type of protective relay, no matter who the manufacturer is.

Some of the topics included in The Relay Testing Handbook series include:

- Basic electrical fundamentals
- Basic relay testing fundamentals
- Relay testing equipment options and how to use them
- Information about the most common protective elements (50/51/67/59/27/81/87/21 protection) including:
  - Theory behind the element
  - How and when the element is applied
  - Step-by-step test procedures
  - Tips and tricks to overcome common problems
- Relay testing approaches and how to select the best ones
- Test plans with real-world applications
- Examples from multiple manufacturers and test-set models

# The Relay Testing Handbook: Principles and Practice

## Fundamentals that all Relay Testers Should Know

The Relay Testing Handbook is an indispensable resource that every relay tester should keep at their fingertips. This book was written for relay testers, rather than design engineers, which means you don't have to decipher engineering textbooks when performing relay tests.

As modern protective relays become increasingly more powerful and complex, many relay testers continue to use test procedures and philosophies that are based on previous generations of relays and their limitations. Modern relays have very different characteristics that require a different testing philosophy to ensure that they will operate when required. This hardback book includes most of the volumes in The Relay Testing Handbook series and includes:

- Electrical fundamentals including three-phase electricity, phasor diagrams, and fault types
- Relay testing fundamentals including what equipment you need and how to use it
- The most commonly used testing philosophies, and the most efficient and effective ones
- How to translate digital logic used by relay manufacturers into familiar concepts
- Best practices for creating and implementing test plans



Entire chapters are dedicated to the most commonly used protective elements including:

- Overvoltage, undervoltage, and frequency (59/27/81)
- Time, instantaneous, and directional overcurrent (51/50/67)
- Simple and transformer differential (87) testing with three or six current channels
- Line distance (21) testing using realistic test plans to minimize setting changes

Each protective element chapter includes:

- A description of operation written for a relay tester, not for a design engineer
- Step-by-step test techniques that maximize your effectiveness and efficiency
- Realistic examples from various relay manufacturers and models

# The Relay Testing Handbook: End-to-End Testing

## Successfully Perform Synchronized Tests at Remote Locations

The Relay Testing Handbook: End-to-End Testing provides a basic introduction to this important testing technique and a step-by-step procedure for performing a successful end-to-end test. This volume also includes an overview of the most common communication-assisted protection schemes to help the reader understand how these schemes operate.

This volume is designed to help you understand:

- The basic principles behind end-to-end testing
- The reasons end-to-end testing is performed
- How end-to-end testing works
- When and where this type of test should be performed
- The following topics are described with realistic, practical examples and detailed instructions:
  - Introduction to end-to-end testing
  - Detailed end-to-end testing procedures



Descriptions of the most common protection schemes including:

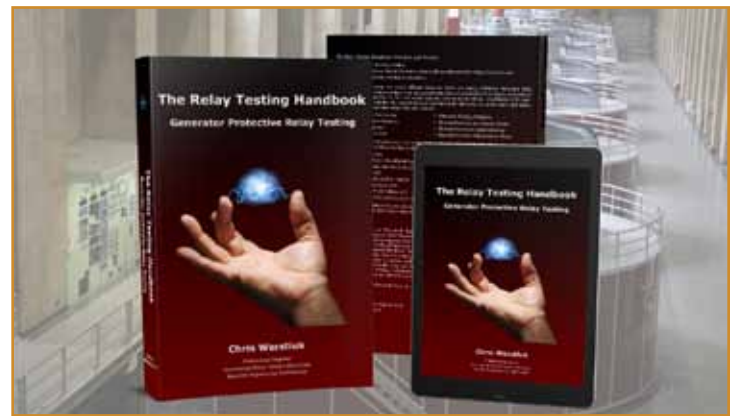
- Direct Under-Reaching Transfer Trip (DUTT)
- Permissive Over-Reaching Transfer Trip (POTT)
- Directional Comparison Unblocking (DCUB)
- Permissive Under-Reaching Transfer Trip (PUTT)
- Directional Comparison Blocking (DCB)
- Line Differential (Pilot Wire, Charge Comparison, Traditional Differential, Alpha Plane)

# The Relay Testing Handbook: Testing Generator Protection

## Test Any Generator Relay with Any Test-Set

Generator relay testing can seem difficult because there are many different elements with different operating characteristics. You can confidently test any generator relay if you understand how a generator operates in the real world and are able to create these conditions with your test-set. This book explains the most important fundamentals that you can understand and apply when testing any generator relay with any test-set:

- Introduction to Generators
- Generator Control Systems
- Generator Diagrams
- Getting Ready to Test
- Element Testing Principles
- How to Perform Acceptance Tests
- How to Perform Commissioning
- How to Perform Maintenance Tests



Once you understand generator and relay testing theory, this book will show you universal, step-by-step test procedures for these elements using modern, dynamic testing techniques:

- Phase Distance (21)
- Volts/Hz (V/Hz) / Over-Excitation (24)
- Synchronizing and Synch-Check (25)
- Under-Voltage (27)
- 100% Stator Earth (27TN / 64G2)
- Reverse/Under-Power (32)
- Loss of Field / Field Failure (40)
- Negative Sequence Over-Current (46)
- Breaker Failure (50BF)
- Inadvertent Energizing (50/27)
- Voltage Control / Restraint Over-Current (51V)
- Neutral Over-Voltage (59N / 64G)
- Fuse Loss / Fuse Failure (60FL)
- Out of Step (78)
- Under- / Over-Frequency (81)
- Phase Differential (87)

Take your relay testing to the next level by learning and applying these dynamic testing principles to any relay element with a fixed time delay. You won't find another resource like this!

# The Relay Testing Handbook: Simplified Motor Relay Testing

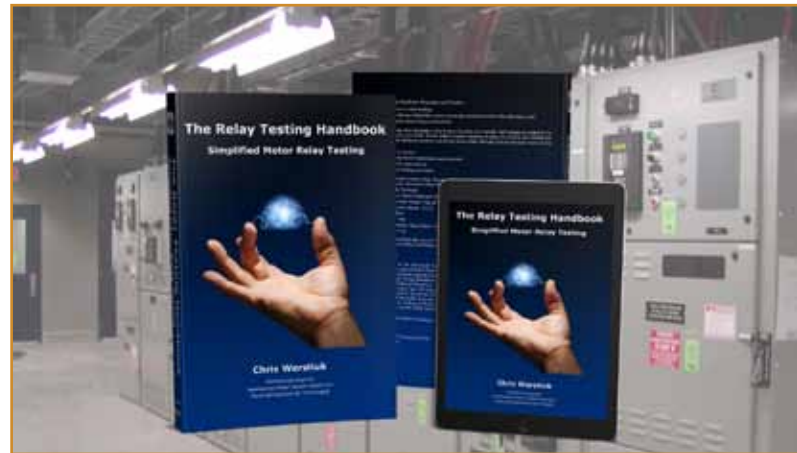
## Test Any Motor Relay with Any Test-Set

Motor relay testing often frustrates relay testers because you usually can't assign an output to be a specific pickup for your tests. Motor relays require dynamic testing for pickup and timing test results. This book will show you how to test any motor relay with any test-set through these motor topics:

- Introduction to motors
- Understanding motor connections and controls
- How to connect your test-set
- General motor testing principles

Once you understand motor relay theory, this book will show you universal, step-by-step test procedures for these elements using modern, dynamic testing techniques:

- Restart Block/Backspin
- Time Between Starts/Starts per Hour
- Thermal Overload Alarm/Trip (49)
- Thermal Capacity Alarm (TCU)
- Mechanical Jam
- Acceleration Trip
- Current Unbalance Trip/Alarm (47)
- Single-Phase Trip
- Short Circuit/Phase Overcurrent (50P)
- Undercurrent/Load Loss/Underpower (37)
- Undervoltage/Overvoltage (27/59)
- Under/Over Frequency (81)
- Power Factor (55)/Reactive Power (VAR)
- Ground Fault Trip (50N)
- Phase Differential (87M)
- RTD Testing



Take your relay testing to the next level by learning and applying these dynamic testing principles to any relay element with a fixed time delay. You won't find another resource like this!



# Online Training

## Online Protective Relay Training

Today's relay testers have to perform more work in less time and typically have very little support to help them test modern digital relays that become more complex every year. We created *The Relay Testing Handbook* series as a practical reference guide for the modern relay tester, but studies have shown that most people must apply multiple learning styles before they fully understand a topic.

We have two different styles of online training programs:

### Online Training Courses:

- Watch a video that discusses the theory behind a topic. You can learn at your own pace with controls that let you pause, rewind, fast-forward, change video speed, watch close-captioning, etc.
- Use our interactive exercises that simulate the topic using the most realistic situations possible to help you learn by doing.
- Repeat the above steps for every topic in the course.
- A certificate will be issued if you pass the final quiz with a score of 80% or higher.



### Online Training Seminars:

- Our online seminars are based on our in-person training classes and are focused on a specific aspect of relay testing. Unlike in-person training classes, you can use closed-captioning, fast-forward/rewind/play speed controls, and you can revisit the videos whenever you wish to help you truly absorb the material.
- Each lesson starts with a short history of the subject, an explanation of why it is important, followed by some theory to help understand the basics, and step-by-step instructions that you can follow along with in order to complete the relay testing task.
- Each lesson is broken down into bite-sized topics that usually include a short (<15 minute) video. Our goal is to always show, not tell.
- We always use real test-sets, relays, and relay settings in our examples and try to simulate real world conditions as closely as possible.
- You will receive a certificate of completion when all topics and lessons have been completed.

### Our online protective relay training courses are designed to:

- Allow you to choose the topics most important to you. You can complete the training in any order.
- Be convenient. You can complete the courses at a location and time convenient for you and your schedule. You have 24/7 access and they never expire. Re-watch the videos as often as you wish.
- Focus on the skills you need to become a better relay tester. You can ask questions anytime.
- Be universally applied to any relay or test-set.

# Online Training Seminars

## How to Test Overcurrent Relays: An Introduction to Protective Relaying Online Seminar: 32 CEUs

This seminar covers the basics of overcurrent protection that new relay testers should know before they start testing relays. It will also fill in gaps for self-taught relay testers who had to figure it out for themselves and want to truly understand how to test all overcurrent relays from any manufacturer with any test-set.

This seminar starts at the beginning by defining the basic operating characteristics of all relays, and the current transformers that feed all overcurrent relays.

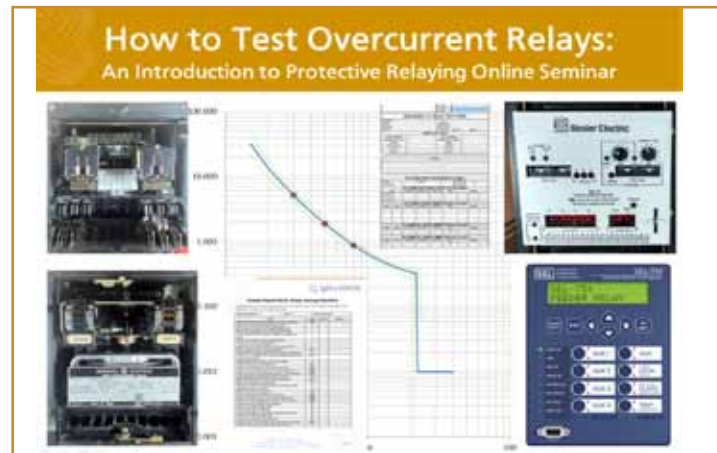
Electro-mechanical relays were the backbone of the power system for over a century and are a great teaching tool for all relay testing because every digital overcurrent relay is modeling electro-mechanical overcurrent relays. The second lesson shows you how to test electro-mechanical overcurrent relays, which sets you up with the basic skills and understanding that you can use for all relay testing.

The third lesson describes the most common kinds of power system faults so that you can troubleshoot problems after a relay operates...and test any relay with fault simulations while using the electro-mechanical relay testing techniques.

The fourth lesson will show you how to apply the skills learned in the electro-mechanical lesson to test and calibrate any digital overcurrent relay using traditional relay testing techniques.

We strongly believe that if you truly understand the theory of a topic, you will be a better relay tester because you will understand what you are testing and be able to find setting mistakes, which are the most common reasons that relays mis-operate when in-service. The fifth lesson will give you a peak behind the curtain and show you how a relay engineer uses engineering studies to create relay settings.

Modern relays should really be called intelligent electronic devices (IEDs) because, while they share some features with traditional overcurrent relays, they are much more complicated and have significantly different failure points. Traditional test techniques won't find these failure points, but you can if you take all of the knowledge and techniques learned in this seminar and apply them to IEDs with the updated overcurrent element testing plan described in the sixth and final lesson.



*"This is an excellent overcurrent relay training course. It can't get better than this. Thank you for the great course! I learned more in this seminar than older experienced EM relay testing trainers have tried to teach me in the past. I have now changed my perspective in my future relay testing practices."*

**Visnu Premchand**  
Student



# Online Training Seminars

## How to Test Overcurrent Relays: An Introduction to Protective Relaying Online Seminar: 32 CEUs (Continued)

### *Introduction to Protective Relays*

- History of Electrical Protection
- What Are Relays For?
- Introduction to Relay Inputs
- Introduction to Current Transformer (CT) Theory
- Introduction to Current Transformer Saturation
- Current Transformer Nameplate and Specifications
- CT Nameplate Burden and Saturation Voltage
- How Relays Protect Equipment
- How Relays Ignore System Fluctuations
- How Overcurrent Relays Coordinate
- Introduction to Zones of Protection
- Relay Output Basics

### *How to Test Electro-Mechanical (E-M) Overcurrent Relays*

- Electro-Mechanical Relay Basics
- Take a Tour of E-M Relay Components
- What to Look for in the E-M Relay's Instruction Manual
- Test-Set Current Channels – Current & VA Specifications
- Test-Set Current Channels – Voltage Requirements
- Test-Set Current Channel Capabilities
- Configuring Test-Set Current Channels for Different Relays and Taps
- How to Connect Test-Set Current Channels to the Relay
- How to Make Test-Set to Relay Sensing Connections
- How to Connect to the Relay
- How to Connect Your Test-Set to the Relay
- How Not to Perform a Pickup Test
- How to Choose the Correct Step Size
- How to Perform an E-M Relay Pickup Test
- How to Evaluate Your Pickup Test Results With % Error
- Why You Can't Always Use Percent Error Tolerances
- How to Apply Tolerances to Test-Set Software
- How to Apply Percent Tolerances to Test-Set Software When the Expected Value Is 0
- How to Perform a Manual E-M Pickup Test
- How to Perform an Automated E-M Pickup Test
- How to Adjust E-M Inverse-Overcurrent Relay Pickups
- What Are TCC Curves and Why Do They Matter?

- How to Determine Test Points and Time Delays
- How to Prepare for 51-Element Time Tests
- How to Perform Manual 51-Element Time Tests
- How to Perform Simple 51-Element Time Tests
- How to Perform 51-Element Time Tests Using Curves
- How to Perform 51-Element Time Tests Using States
- How to Adjust the Timing on an E-M Relay
- Introduction to E-M 50-Elements
- How to Perform a 50-Element Pickup Test
- How to Perform a Manual 50-Element Pickup Test
- How to Perform a 50-Element Pickup Test
- How to Adjust a 50-Element Pickup on an E-M Relay
- How to Perform a Dynamic 50-Element Pickup Test
- Introduction to Electro-Mechanical Targets
- How to Test Electro-Mechanical Relay Targets
- How to Use a Test-Set to Test E-M Targets
- How to Manually Test E-M Targets With Your Test-Set
- How to Test E-M Targets With Your Test-Set
- How to Test E-M Relays Using Pre-Built Test Plans
- How to Inspect the Cover and Case
- How to Perform a Mechanical Inspection of the Relay
- How to Inspect the Relay's Contacts
- How to Perform a Creep Test
- How to Perform a Mechanical Zero Test
- How to Perform an Insulation Resistance Test
- How to Verify the Relay's Trip Circuit (NERC)
- How to Safely Put the Relay Back Into Service
- How to Verify the In-Service Relay Inputs (NERC)
- Are Electro-Mechanical Relay Testing Myths True?
- Putting It All Together – How to Test an Electro-Mechanical Overcurrent Relay From Start to Finish
- All the Extras – Downloads and More Training Options

### *Understanding Power System Faults*

- Overcurrent Relays Under Normal Conditions
- What Happens During a Fault
- Fault Voltage and Fault Current During 3-Phase Faults
- How E-M Overcurrent Relays Respond to 3-Phase Faults
- Fault Current Magnitude and Direction in P-P Faults
- Fault Current vs. Phase Current in P-P Faults
- Fault Voltages in Phase-to-Phase Faults

# Online Training Seminars

## How to Test Overcurrent Relays: An Introduction to Protective Relaying Online Seminar: 32 CEUs (Continued)

- What Phase Voltages Look Like During P-P Faults
- Fault Voltages and Fault Current in Phase-Phase Faults
- How E-M OC Relays Respond to P-P Faults
- Fault Voltage and Fault Current in P-N Faults
- How E-M OC Relays Respond to P-N Faults
- Benefits of E-M OC Relays
- What Faults Really Look Like
- Applying Realistic Faults When Testing Relays

### *How to Test Simple Digital Overcurrent (SDO) Relays*

- Introduction to Simple Digital Overcurrent Relays
- How to Prepare to Test a Simple Digital Overcurrent Relay
- How to Prepare to Test an SDO Relay With Your Test-Set
- How to Connect to a Simple Digital Overcurrent Relay
- How to Connect an SDO Relay to Your Test-Set
- How to Configure Inputs When Testing Digital Relays
- How to Create a 51-Pickup Test Plan for an SDO Relay
- How to Perform Manual Pickup Tests on an SDO Relay
- How to Adjust the 51-Pickup on an SDO Relay
- How to Perform a Ramping 51-Pickup Test on a Simple Digital Overcurrent Relay With Your Test-Set
- How to Create a 51-Timing Test Plan for an SDO Relay
- How to Perform 51-Timing Tests on an SDO Relay
- How to Perform 51-Timing Tests on a Simple Digital Overcurrent Relay With Your Test-Set
- How to Create a 50-Pickup Test Plan for an SDO Relay
- How to Adjust the 50-Pickup on an SDO Relay
- How to Perform a 50-Pickup Test on a Simple Digital Overcurrent Relay With Your Test-Set
- How to Verify the Outputs on an SDO Relay
- How to Verify the Targets on an SDO Relay
- How to Put the SDO Relay Back Into Service
- How to Verify the Trip Circuit Connected to an SDO Relay
- How to Verify the In-Service Relay Inputs Connected to a Simple Digital Overcurrent Relay
- Putting It All Together
- Putting It All Together With Your Test-Set
- All the Extras – Downloads and Additional Training

### *Introduction to the Power System Studies Used to Create Relay Settings*

- Introduction to Power System Study Single Line Drawings
- Introduction to Load Flow Studies
- How to Calculate the Maximum Fault Current Using An Infinite Buss
- How Does the System MVA Affect the Fault Voltage and Current in a System
- How Does an Impedance Affect the Fault Voltage and Current in a System
- How Does a Connected Motor Affect the Fault Voltage and Current in a System
- Introduction to Short Circuit Studies
- Introduction to Time Coordination Curves for Relays
- Introduction to Time Coordination Curves for Cables
- Introduction to Time Coordination Curves for Transformers
- Introduction to Time Coordination Curves (TCCs) Through Transformers
- Introduction to Time Coordination Curves for Motors
- How Motors Affect Non-Motor Relay Coordination
- Introduction to Arc Flash
- How Relay Settings Affect Arc Flash
- How to Get Time Test Values From a TCC Chart
- How to Get Time Test Values From a Coordination Study
- All the Extras – Downloads and Additional Training

### *How to Test Overcurrent (50/51) Elements in IEDs*

- What You Need to Test 50/51 Elements Inside an IED
- How You Should Test the 50/51 Elements Inside an IED
- How to Prepare to Test the 50/51 Elements Inside an IED
- How to Test the Phase 50/51 Elements Inside an IED
- How to Test the Ground 50/51 Elements Inside an IED
- How to Test the Electro-Mechanical Reset Overcurrent Elements Inside an IED
- How to Review and Report Your 50/51 Element IED Tests
- How to Test the 50/51 Elements Inside an IED
- All the Extras – Downloads and Training Options

# Online Training Seminars

## How to Test Protective Relays, 16 CEUs

This online protective relay testing seminar follows Chris Werstiuk (author of *The Relay Testing Handbook*) as he tests a relay from start to finish. You'll learn the basic skills needed to test any digital relay with any modern test-set, how to perform each testing step, and why each step is important.

You'll see how to make smarter test plans that are quicker and more effective than traditional methods (including tips and tricks you won't find in any manual or YouTube video).

Watch this series of videos on any device with speakers or headphones, and a high-speed internet connection. The videos are broken down into logical chunks that you can watch at any time, and in any order, to fit this series into your busy schedule.

### What do I get when I enroll in the "How to Test Protective Relays Online Seminar" today?

- Download a simple flowchart to follow while testing digital protective relays with any test-set.
- Unlimited access to 17+ hours of videos where Chris Werstiuk tests various relays using different test-sets, and explains how he performs the test, and why.
- Content to download and follow along.
- Comment sections to ask Chris questions, and interact with other students.
- Ask for more content if you don't see your relay or test-set represented in the course.



*"This is a fantastic course in how to test relays and covers aspects that are not found anywhere else - set up, print and documentation review, testing philosophy, the testing process and reporting results. The quality of the material in these videos and Chris's engaging delivery have led me to be infinitely more prepared to take on the task of relay testing than ever before."*

**Benjamin**

*How to Test Protective Relays Seminar*

*"Chris is extremely knowledgeable and experienced. He has seen almost every mistake that can be made in the protection and control game. This course will provide you with a great step-by-step guide to testing. Not only will you have a good guide, but you will understand WHY you are doing that step."*

**Student**

*How to Test Protective Relays Seminar*

# Online Training Seminars

## How to Test Protective Relays, 16 CEUs (Continued)

This seminar explains how to test protective relays using Chris' decades of relay testing experience and nearly a decade of relay testing training to make smarter test plans that are more effective and more efficient than traditional test plans.

### *What do you cover in this online protective relay testing seminar?*

We cover the following information using a variety of relays and test-sets for every topic:

#### **Introduction Videos**

- Electromechanical relays
- Review Documentation
- Create a Checklist
- Isolate and Connect to the Relay
- Upload the Relay Settings
- Decide What Kind of Test to Perform
- Perform an Acceptance Test
- Introduction to Common Test Procedures
- Old Test Procedures
- Understand the Element
- Choose the Fault Type for Your Test
- How to Perform a Pickup Test
- How to Perform a Timing Test
- How to Evaluate Your Test Results
- How to Perform Simple Logic Tests
- How to Perform Complex Logic Tests
- How to Test the Non-Tripping Logic
- Final Tasks and Conclusion
- How to Test All Remaining Logic
- Final Tasks and Conclusion

#### **Obtain and Review the Relay Settings, Drawings, and Application**

- Obtain and Review the Relay AC Single-Line Drawings
- Obtain and Review the Relay AC Three-Line Drawings
- Obtain and Review the Relay DC Drawings
- Obtain and Review the Relay Main Settings
- Obtain and Review the Relay Logic Settings
- Obtain and Review the Relay Global and Port Settings
- How to Understand and Determine Phase Rotation in a Power System- TechTalk Post
- How to Measure Phase Angles with a Phase Angle Meter – TechTalk Post



#### **Create a Checklist of all Elements, Outputs, and Signals to be Tested**

- Create a Checklist of All Elements to be Tested
- Create a Test Checklist of all Logic, Outputs, and Signals

#### **Isolate the Relay From the System**

- Understanding FT Style Test Switches
- Isolate the Relay From the System

#### **Connect the Test Set to the relay**

- Connect the Test-Set to the Relay
- Connect the Test-Set to the Relay - Alternate DC Connections
- Connect the Test-Set to the Relay - Alternate AC Connections
- Connecting Omicron Test-Sets to the Relay

#### **Upload the Relay Settings**

- Serial Connections
- Ethernet Communication
- Upload SEL Relay Settings
- Upload GE Relay Settings
- Upload Siemens Relay Settings
- Upload ABB Relay Settings

# Online Training Courses

## How to Test Protective Relays, 16 CEUs (Continued)

### *Perform an Acceptance Test*

- Record the Relay Self-Test Results
- Check all Digital Inputs and Outputs on SEL Relays
- Check all Digital Inputs and Outputs on GE UR Relays
- Check all Digital Inputs and Outputs on GE SR Relays
- Check all Digital Inputs and Outputs Beckwith Electric Relays
- Check all Digital Inputs and Outputs - Siemens Relays
- Check all Digital Inputs and Outputs on ABB Relays
- Understanding Phase Angles
- Perform a Meter Test - Option 1 - Balanced Three-Phase
- Perform a Meter Test - Option 2 - Unbalanced Three-Phase
- Perform a Meter Test - Option 3 - Combined Meter Test
- Perform a Meter Test With Different Test Sets
- Perform a Meter Test - Open-Delta PTs and GE SR Relays
- Perform a Meter Test - GE UR Relays
- Perform a Meter Test - Beckwith Electric Relays
- Perform a Meter Test - Siemens Relays
- Perform a Meter Test on ABB Relays
- Why Does My Open-Delta Connected Phasor Diagram Look Weird?

### *How to Test Protective Relay Elements*

- Percent Error and Metering Specifications
- Relay and Element Specifications
- Understand the Basic Operation of the Element - SEL 50
- Understand the Basic Operation of the Element - SEL 51
- Understand the Basic Operation of the Element - GE & Siemens
- Understand the Basic Operation of the Element on ABB Relays
- Understanding The Power System
- Choose the Appropriate Fault Type for the Test - Three Phase Faults
- Choose the Appropriate Fault Type for the Test - Phase-Ground Faults
- Choose the Appropriate Fault Type for the Test - Phase-Phase Faults
- Perform a Ramping Pickup Test via Relay Setting Changes
- Perform a Ramping Pickup Test via the SEL TAR Command
- Perform a Ramping Pickup Test via Software and Front Panel - SEL
- Perform a Ramping Pickup Test via Software and Front Panel - GE SR
- Perform a Ramping Pickup Test via Software and Front Panel -GE UR
- Perform a Ramping Pickup Test via Human Machine Interface (HMI) -Beckwith
- Perform a Ramping Pickup Test via Human Machine Interface (HMI) - Siemens
- Perform a Ramping Pickup Test via Human Machine Interface (HMI) - ABB
- Perform a Manual Ramping Pickup Test with Different Test Sets -Omicron
- Perform a Ramping Pickup Test via Automatic Ramp - Manta
- Perform an Automatic Ramping Pickup Test with Omicron
- Perform a Ramping Pickup Test via Hybrid Ramp - Manta
- Perform a Ramping Pickup Test via Hybrid Ramp - Omicron
- Perform a Manual Pulsing Pickup Test with Omicron
- Perform Manual Pulsing Pickup Tests with Manta
- Perform an Automatic Phase to Phase Pulsing Pickup Test with Omicron
- Perform an Automatic Phase to Ground Pulsing Pickup Test with Omicron
- Perform Automatic Pulsing Pickup Tests with Manta
- Troubleshooting Pulsing Pick Up Tests
- Perform a Generic Inverse Timing Test with Omicron
- Perform Generic Inverse Timing Tests with Manta
- Perform Generic Inst/Def Timing Tests with Omicron
- Perform Generic Inst/Def Timing Tests with Manta
- Perform Dynamic Pickup/Timing Tests with Omicron
- Perform Dynamic Pickup/Timing Tests with Manta - Part 1
- Perform Dynamic Pickup/Timing Tests with Manta - Part 2
- How to Perform Dynamic Relay Testing on Digital Relays



# Online Training Courses

## How to Test Protective Relays, 16 CEUs (Continued)

### *Perform a Commissioning Test*

- Putting it all Together with Standard Tests and Omicron
- Putting it all Together with Standard Tests and Manta
- Putting it all Together with Universal Tests
- Testing Multiple Physical Outputs with Omicron
- Testing Multiple Physical Outputs with Manta Test Systems
- Understanding Digital logic - Part 1
- Understanding Digital logic - Part 2
- Understanding Digital logic - Part 3
- Testing Digital Logic
- Testing Digital Logic with Manta Test Systems
- Testing Digital Logic with Omicron
- Testing Non-Contact Outputs
- Testing Non-Contact Outputs with Checklists
- Testing Non-Contact Outputs with Omicron
- Putting It all Together with Dynamic Tests and other Elements
- Putting it all Together with Dynamic Tests and Manta
- Can Dynamic Tests Replace Traditional Tests?
- Testing Directional Elements with Dynamic Tests
- Putting it all Together with Dynamic Tests and Omicron - Overcurrent-1
- Putting it all Together with Dynamic Tests and Omicron - Overcurrent-2
- Putting it all Together with Dynamic Tests and Omicron - Overcurrent-3
- Putting it all Together with Dynamic Tests and Other Elements - Omicron
- Putting it all Together with Dynamic Tests and Other Elements - Manta
- Reviewing Sequence of Event Reports

### *Perform Maintenance Tests*

- Download All Settings, Events, and Meter Logs
- Download All Settings, Events, and Meter Logs - SEL
- Download All Settings, Events, and Meter Logs - Beckwith Electric
- Download All Settings, Events, and Meter Logs - GE SR Relays
- Download All Settings, Events, and Meter Logs - GE UR Relays
- Download All Settings, Events, and Meter Logs - Siemens Relays
- Download All Settings, Events, and Meter Logs on ABB Relays
- Perform the Relay's Self-Test and Record Results
- Perform a Meter Test and Record Results
- Verify All External Inputs and Watch them Change State in the Relay
- Verify All Outputs

### *Post Testing Tasks*

- Clear Metering, Sequence of Events, and Oscillography Records - SEL
- Clear Metering, Sequence of Events, and Oscillography Records - GE SR
- Clear Metering, Sequence of Events, and Oscillography Records - GE UR
- Clear Metering, Sequence of Events, and Oscillography Records - Beckwith Electric
- Clear Metering, Sequence of Events, and Oscillography Records - Siemens Relays
- Metering, Sequence of Events, and Oscillography Records on ABB Relays
- Return The Relay to Service
- How to Perform an In-Service Protective Relay Meter Test
- Submit Your Report

### *Final Thoughts on Relay Testing*

- Description of Operation
- Conclusion



# Online Training Courses

## Course 1-1: The Three-Phase Electric Power System, 4 CEUs

Protective relays constantly look at the three-phase electric power system and try to decide whether the system is normal or under fault conditions. A relay tester who understands the three-phase electrical system can build highly efficient test plans to test the entire relay (not just the individual pieces of it) to make sure it actually operates when it's supposed to.

We will cover the following topics in this lesson to give you a foundation in three-phase electrical theory to help you become a craftsman instead of a button pusher:

### *Introduction to Electrical Fundamentals and Frequency*

- How electricity is created
- What is a cycle
- How to count cycles
- Understand how frequency and cycles are related
- Converting cycles to seconds
- Converting seconds to cycles
- Converting cycles to cycles



### *Three-Phase Electric Power Systems*

- How three-phase electric power systems are created
- How to determine which kind of three-phase electric power system is being generated
- How to change one kind of three-phase electric power into another

*"I learned a lot from this course. Having no relay testing experience, I was grateful the real world examples were shown. I will definitely continue with this program, as they become available."*

**Joe**  
*The Three-Phase Electric Power System*

*"Excellent refresher for someone in the field who doesn't deal with phasors and/or frequency/time/cycle conversions very often."*

**Student**  
*The Three-Phase Electric Power System*

# Online Training Courses

## Course 1-2: Phasor Drawings for Relay Testers , 4 CEUs

Phasor diagrams are used to understand the electrical system at a glance. Unfortunately, your test-set probably has a different phase angle system than your meter or relay, which can make relay testing a nightmare. How are you supposed to translate phase angles between devices that use different references?

This course introduces you to phasors in seven detailed video lessons and quizzes, which cover:

- Understanding Phasors
- Drawing Phasor Drawings
- Drawing Phasors with Lagging Angles for GE SR Relays, Megger Equipment, and RTS Software
- Drawing Phasors with Different Scales

In a perfect world, these four lessons would be all you needed to become a phasor drawing master. Unfortunately, it seems every manufacturer has a different system for the angles in phasor drawings. The remaining lessons in this course help you understand all of the different angle systems used by all the major equipment vendors:

- Drawing Phasors with Positive Angles for Manta and Doble test-sets
- Drawing Phasors with Negative Angles for GE UR relays
- Drawing Phasors with Positive and Negative Angles for SEL, SIEMENS, ABB, and Alstom relays (and most equipment not listed)



*"For people who feel they may know some details about relay testing but get confused by the different phase angles and phase rotation. It clears up the differences and opens your eyes to the need to be careful when trying to figure out phase rotation."*

### Customer Review

*Phasor Drawings for Relay Testers*

*"If you want to take your relay testing knowledge to the next level, this course is a must!"*

### Student Course Evaluation

*Phasor Drawings for Relay Testers*

# Protective Relay Testing Training

## Effective, Hands-On Training for Relay Testers

Valence Electrical Training Services has shown its commitment to the high-voltage electrical testing industry with *The Relay Testing Handbook* series and our online training series. Many people we have met over the years have requested a complete training program so that their test technicians will be able to answer all of these questions:

- What is a protective relay?
- Where are protective relays used?
- Why do protective relays need to be tested?
- What are the most common protective relay functions?
- How do I test any protective relay or element?
- What are the most effective test techniques available?

Most protective relay training classes are equipment specific, include over four days of training, and are based on decades-old material. This means that the student only learns one way to test the relay, can become overloaded with too much or dated information, and requires overtime travelling to and from the training site.

We have combined all of our training experience to create a modern curriculum for today's relays and test equipment. Our class sizes, topics, and durations have been carefully planned to make sure our trainees actually retain the information they obtain in the class through a combination of theory and hands-on training. We use modern relays and techniques that can be applied to any modern test set from any manufacturer.

All of our in-person training classes include post-training services where students can ask those questions they didn't think of while attending the class and consult with relay testing experts to help them after the classes are complete.

While we focus on ensuring that students graduate with the knowledge and skills they need to become effective relay testers, we understand that recognition is also important. All of our graduates receive a certificate of completion that can be used with your regulating board, and each class has been pre-approved for the number of NETA Continuing Education Units (CTDs) listed in each class description.



# Introduction to Modern Relay Testing

3-Day Class, 24 CEUs

## *Why do I want to take this class?*

Modern protective relays can be extremely complex or relatively simple, depending on the relay model and design engineer. It is possible to use some testing techniques from previous relay generations, but these techniques only test individual elements which does not guarantee the relay is set correctly or will operate when required.

Most modern relay problems have nothing to do with the actual relay as supplied by the manufacturer. Today's relay problems occur when the relay has been incorrectly connected to the power system, or was set incorrectly by the design engineer. Unfortunately, these problems cannot be detected by traditional relay testing techniques that reprogram the relay in order to get the right test value for the test sheet. These techniques don't ask the right questions to find the problems that prevent the relay from operating and they are never discovered until the relay is needed most, and it fails to operate.



Modern relay testers must apply several different skill sets to effectively test digital relays so that they can get the test results they need for their reports, and make sure the relay is properly applied. This class provides the basic skills every modern relay tester should have, including:

- Understanding the power system
- Understanding why and how protective relays are applied
- Understand phasors and phasor diagrams
- Understanding what these numbers mean? (50/51/67/etc.)
- Comparing single-line, three-line, manufacturer, and DC drawings
- Communicate with relays and test-sets
- Building effective and efficient test plans
- Applying basic relay testing procedures
- Understanding digital relay logic

### ***Day 1 Topics***

1. Class Introduction
2. Power System Basics
3. Protective Relay Introduction
4. Phasor Diagrams

### ***Day 2 Topics***

1. Comparing Drawings
2. IEEE Designations  
(50/51/67/etc.)
3. Communication Protocols
4. Communicating with Relays

### ***Day 3 Topics***

1. Understanding Relay Settings
2. Relay Testing Techniques
3. Digital Logic
4. Creating Test Plans
5. Applying Test Plans

# Protective Relay Testing Fundamentals

3-Day Class, 24 CEUs

## *Why do I want to take this class?*

Good relay testers need a solid foundation to build from, and the graduates from this program will understand and be able to test the most common functions enabled on any feeder relay such as:

- Time Overcurrent (51)
- Instantaneous Overcurrent (50)
- Overvoltage (59) / Undervoltage (27)
- CO-x or IAC-xx
- Schweitzer Engineering Laboratories SEL-351
- General Electric SR-750

## *Who should take this class?*

We recommend that all relay technicians take the Protective Relay Testing Fundamentals class to ensure that they have a solid foundation before attending any of the other courses. We don't just discuss the mechanics of the topics above; we review all of the fundamentals that every relay tester should know.



## *Which prerequisites are required?*

Prospective students should have a basic understanding of the power system such as Watts, VARs, Ohm's Law, etc.

### *Day 1 Topics*

1. Introduction to Relays
2. Introduction to Test-Sets
3. Introduction to The Power System
4. How to Perform a Meter Test
5. Overcurrent Protection Theory (51/51)
6. How to Prepare for Relay Testing
7. Testing E-M Overcurrent Relays
  - a. 51 Overcurrent Pickup Tests
  - b. 51 Overcurrent Time Tests
  - c. 50 Overcurrent Pickup Tests

### *Day 2 Topics*

1. E-M Relay Target Testing
2. Review E-M Relay Testing
3. Testing Digital Relays
4. Understanding Fault Types
5. Pickup Testing Options
6. Testing Ground Time Overcurrent (51N/51G/50N/50G)
7. Testing Phase Time Overcurrent (51P/50P)
8. Dynamic Testing Principles

### *Day 3 Topics*

1. Digital Relay Testing Review
2. Digital Relay Testing Practice
3. Testing Overvoltage Elements (59)
4. Testing Undervoltage Elements (27)
5. Testing Under/Over Frequency Elements (27) \*\*Optional
6. Testing Directional Overcurrent Elements (67) \*\*Optional
7. Testing Synchronizing Elements (25) \*\*Optional

# Line Distance Protective Relay Testing Class

3-Day Class, 24 CEUs

## Why do I want to take this class?

Utility environments and transformer relays can be more complicated than the simple feeder relays usually found in industrial environments. This class builds on the Protective Relay Testing Fundamentals Class to create relay testers who can test transmission line relays; such as:

- Directional Overcurrent Protection (67)
- Impedance Protection (21)
- Synch-Check (25) \*Optional
- Schweitzer Engineering Laboratories  
SEL-311x, 321, etc.
- General Electric UR Dx0, Fx0

## Who should take this class?

Relay technicians who are comfortable testing overcurrent (51/51), over/under voltage (27/59), and over/under frequency (81) elements and want to test the majority of relays installed on the electrical system.



## Which prerequisites are required?

Prospective students should have completed the Protective Relay Testing Fundamentals Class, or been approved by a Valence instructor.

### Day 1 Topics

1. Introduction
  - a. Power Systems
  - b. Substation Configurations
  - c. Zones Of Protection
2. Testing Directional Overcurrent Elements (67)
3. Introduction to Distance Protection (21)
  - a. Line Impedance
  - b. Impedance Diagrams
  - c. Impedance Formulas

### Day 2 Topics

1. Testing Zone-1 Distance Protection (21)
  - a. MTA Tests
  - b. Reach Tests
  - c. Timing Tests
2. Testing Zone-2 Distance Protection (21)
  - a. Three-Phase
  - b. Phase-Phase
  - c. Phase-Ground
3. Dynamic Relay Testing

### Day 3 Topics

1. Testing Multi-Zone Protection Practice
2. Introduction To Synch-Check
3. Testing Synch-Check Relays
  - \* Optional
  - a. Delta V
  - b. Undervoltage Block
  - c. Overvoltage Block
  - d. Delta Phase
  - e. Slip Frequency
  - f. DL/LB, LL/LB, LL/DB



# End-To-End Communication Testing Class

2-Day Class, 16 CEUs

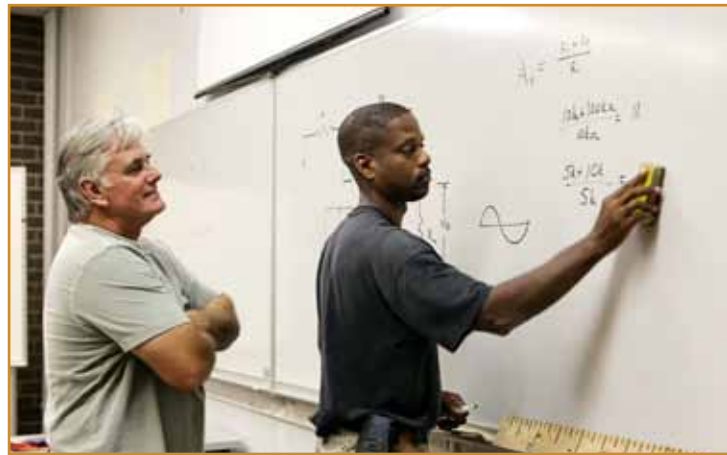
## *Why do I want to take this class?*

Communication-assisted protection schemes are becoming increasingly common as technology improves. Testing these schemes requires specialized equipment and knowledge that is hard to find. This class builds on the Line Distance Protective Relay Testing Class to create relay testers who can perform end-to-end testing on communication-assisted transmission line relays, such as:

- Permissive Over-reaching Transfer Trip (POTT)
- Permissive Under-reaching Transfer Trip (PUTT)
- Directional Comparison Blocking (DCB)
- Schweitzer Engineering Laboratories  
SEL-311x, 321, 421, etc.
- General Electric UR Dx0, Lx0

## *Who should take this class?*

Relay technicians who are comfortable testing line distance/impedance elements and want to test communication-assisted trip schemes.



## *Which prerequisites are required?*

Prospective students should have completed the Line Distance Protective Relay Testing Class or been approved by a Valence instructor.

### **Day 1 Topics**

1. Introduction
  - a. What are Communication-Assisted Trip Schemes
  - b. What Is End-to-End Testing
2. Introduction to Test Cases
  - a. Fault Simulations
  - b. COMTRADE Files
3. End-to-End Test Procedures
  - a. Obtain and Review All Test Cases
  - b. Set up the GPS Antenna
  - c. Apply a Meter Test
  - d. Apply the Test Plan
  - e. Review the Results

### **Day 2 Topics**

1. Test Direct Transfer Trip (DTT) Schemes
2. Test Direct Under-Reaching Transfer Trip (DUTT) Schemes
3. Test Permissive Over-Reaching Transfer Trip (POTT) Schemes
4. Test Permissive Under-Reaching Transfer Trip (PUTT) Schemes
5. Test Directional Comparison Blocking (DCB) Schemes
6. Test Differential Schemes

# Differential Protective Relay Testing Class

2-Day Class, 16 CEUs

## *Why do I want to take this class?*

Differential protection can be the most complicated relays to test because the test procedures are opposite of most other protective elements. Graduates of this class builds on the Protective Relay Fundamentals topics to help them understand and test all aspects of differential protection and relays, such as:

- Minimum Pickup
- Slope 1 / Slope 2
- Harmonic Restraint
- Phase Shifts Between Windings
- Schweitzer Engineering Laboratories  
SEL-387, 787, 487 etc.
- General Electric UR Tx0, SR745



## *Who should take this class?*

Relay technicians who are comfortable testing overcurrent (51/51) protection and want to understand and test differential relays.

## *Which prerequisites are required?*

Prospective students should have completed the Protective Relay Testing Fundamentals Class, or been approved by a Valence instructor.

### **Day 1 Topics**

1. What is Differential Protection
2. Differential Calculations
  - a. Tap
  - b. Per Unit
  - c. Operate/Restraint Current
  - d. Slope 1/Slope 2
3. Testing Differential Protection
  - a. Minimum Pickup
  - b. Slope 1
  - c. Slope 2

### **Day 2 Topics**

1. Understanding Phase Shifts on Delta/Wye Transformers
  - a. Yy0 (YY), Dd0 (DDAB/DDAC)
  - b. Yd1 (YDAC), Dy1 (DABY)
2. Harmonic Restraint Testing
  - a. 2nd Harmonic
  - b. 5th Harmonic
3. Unrestrained Differential Testing
  - a. Minimum Pickup
  - b. Time Delay

# Generator Protective Relay Testing Class

3-Day Class, 24 CEUs

## *Why do I want to take this class?*

Generator relays are probably the most complex protective relays installed on the electrical system and have many different protection elements to protect the generator from various problems. Graduates of this class will build on the Protective Relay Fundamentals and Advanced class topics and will be able to test these additional elements and relays:

- Backup Overcurrent (51V)
- Reverse Power (32)
- Negative Sequence (46)
- Loss of Field (40)
- Volts per Hertz (24)
- Neutral Voltage (27TN/59N)
- Breaker Fail (50BF)
- Inadvertent Energization (50/27)
- Schweitzer Engineering Laboratories SEL-300G
- General Electric Multilin SR-489, G-x0
- Beckwith M-34xx



## *Who should take this class?*

Relay technicians who are comfortable testing overcurrent (51/51), over/under voltage (27/59), over/under frequency (81), impedance (21), and differential (87) elements and want to test any generator relay.

## *Which prerequisites are required?*

Prospective students should have completed the Protective Relay Testing Fundamentals and Advanced classes, or been approved by a Valence instructor.

### **Day 1 Topics**

1. Introduction To Generators
2. Testing Overvoltage (59)
3. Testing Undervoltage (27)
4. Testing Under/Over Frequency (81)
5. Testing Impedance (21)
6. Testing Voltage Controlled / Restrained Overcurrent (51V)

### **Day 2 Topics**

1. Testing Negative Sequence Overcurrent (46)
2. Testing Reverse Power (32)
3. Testing Loss Of Field (40)
4. Testing Volts/Hertz (24)
5. Testing Inadvertent Energization (50/27)
6. Testing Breaker Fail (50BF)

### **Day 3 Topics**

1. Testing Differential (87)
2. Testing Neutral Overvoltage (59N)
3. Testing 100% Ground Protection (27TN)
4. Testing Out Of Step (78)  
\*\*Optional
5. Testing Synchro Relays (25)  
\*\*Optional

# Testing Digital Relay Logic Testing Class

2-Day Class, 16 CEUs

## Why do I want to take this class?

Version controlled electrical schematics used to be the method for determining what was supposed to happen inside a switchgear panel or control cabinet. Many, if not all, of these functions have been replaced with digital logic in digital relays, HMIs, and SCADA systems that all use different terminology and symbols to express their functions.

Relay testers can no longer open up the schematic drawing and get to work. They must be able to:































- Communicate with the relay or control device
- Translate all of the different logic schemes into something recognizable
- Functional test the logic scheme to ensure it will work correctly in the application

## Who should take this class?

Relay technicians who are comfortable testing protective relay elements and want to test the entire relay.

## Which prerequisites are required?

Prospective students should have completed the Protective Relay Testing Fundamentals class or been approved by a Valence instructor.

DESCRIPTOR	SYMBOL	MATRIX	ELECTRICAL EQUIVARIANT
OR		1 1 0 1	
		1 0 1 1	
		0 1 1 0	
AND		1 1 1 1	
		1 0 0 0	
		0 1 0 0	
NOT		0 1 1	
		1 0 0	
		1 1 0	
NOR		1 1 0 0	
		1 0 0 0	
		0 1 0 0	
NAND		1 1 0 0	
		1 0 1 1	
		0 1 1 0	
XOR		1 1 0 0	
		1 0 1 1	
		0 1 1 0	
XNOR		1 1 1 1	
		1 0 0 0	
		0 1 0 0	
DESCRIPTOR	SYMBOL	MATRIX	1
			

## Day 1 Topics

1. Introduction to Symbols
  - a. Contacts vs. Switches
  - b. Timing vs. Latching Relays
  - c. Normally Open vs. Normally Closed
  - d. Fail-Safe vs. Non Fail-Safe
2. Introduction to Schematics
  - a. Trip Circuits
  - b. Close Circuits
  - c. Anti-Pump Circuits
  - d. Seal-In Circuits
3. Introduction to Logic Gates
  - a. OR Gates
  - b. AND Gates
  - c. Not

## Day 2 Topics

1. Introduction to Relay Digital Logic
  - a. Element Schemes (GE SR Relays)
  - b. Binary Schemes (Alstom Relays)
  - c. Grid Schemes (Siemens / Beckwith Relays)
  - d. Arithmetic Schemes (SEL Relays)
  - e. Gate Schemes (GE UR / ABB Relays)
2. Converting Between Logic Schemes
3. Testing Logic Schemes
  - a. Traditional trip Schemes
  - b. Conditional Trip Schemes
  - c. Breaker Fail Trip Schemes
  - d. Conditional Closing Schemes
  - e. Synchronizing Logic Schemes

# Motor Protective Relay Testing Class

2-Day Class, 16 CEUs

## Why do I want to take this class?

Motor protection relays could be the most common relay found at any industrial site and they have very specific protection features because of the induction motor's unique operating characteristics. Graduates of this class will build on the Protective Relay Testing Fundamentals and/or Advanced class topics and will be able test these additional elements and relays:

- Overload (49)
- Start Blocking
- Mechanical Jam
- Acceleration Trip
- Unbalanced Overcurrent
- RTD Testing
- Schweitzer Engineering Laboratories  
SEL-701, SEL-749
- General Electric Multilin SR-x69



## Who should take this class?

Relay technicians who are comfortable testing overcurrent (51/51), over/under voltage (27/59), and over/under frequency (81) elements and want to test motor protection relays.

## Which prerequisites are required?

Prospective students should have completed the Protective Relay Testing Fundamentals class or been approved by a Valence instructor.

### Day 1 Topics

1. Introduction
2. Meter Testing
3. Overload Trip Protection (49T)
4. Overload Alarm Protection (49A)
5. Starts Per Hour / Time Between Starts Blocking
6. Mechanical Jam Protection
7. Acceleration Trip Protection

### Day 2 Topics

1. Previous Day Review
2. Unbalance Alarm
3. Unbalance Trip
4. Short Circuit Protection (50)
5. Ground Fault Alarm Protection (50G)
6. Ground Fault Trip Protection (50G)

### Day 3 Topics

1. Previous Days Review
2. Differential Protection (87)
3. Overvoltage Protection (59)
4. Undervoltage Protection (27)
5. Over Frequency Protection (81)
6. Under Frequency Protection (81)
7. Rtd Protection

# Frequently Asked Questions (FAQ)

## ***Are your instructors qualified?***

All of our instructors started in the field testing relays and have extensive experience with manufacturers, models, test-sets, and relays. They are industry leaders and have recurring instructor/presenter/author/contributor roles at major industry events and organizations such as:

- InterNational Electrical Testing Association (NETA)
  - Powertest Conference
  - NETA World Magazine
- Western Institute Hands-On Relay School
- TEGG
- Pacific Gas and Electric
- MidAmerican Energy
- Xcel Energy
- Transalta Utilities
- USACE
- Seattle City Light

## ***How Do the Classes Work?***

We schedule a three-day time for our instructor to come to your classroom/boardroom setting free from distractions with a projection system and whiteboards. We can have up to five workstations that include:

- A maximum of two students.
- The appropriate relay for the class. (We can supply relays for all classes if spares are not available.)
- A protective relay test-set provided by you.
- A laptop supplied by you with your test-set and relay software pre-installed and updated.
- Test leads and communication cables provided by you.
- Three-line drawings, single-line drawing, schematics, and logic diagrams from a previous or future job.

## ***How Much does a Class Cost?***

We can provide an all-inclusive quote (usually between \$7,500 - 10,500 USD, depending on your location) for training at your location.

## ***How Many Students can Attend?***

We typically recommend a maximum of 10 students for the most effective learning environment.

## ***Which kind of credits are provided?***

You will get a certificate of completion after every class that you can use for continuing education credits from the appropriate organizations. We have been pre-approved for CTD credits from the InterNational Electrical Testing Association (NETA) as indicated in the header of each class page. We will work with you as much as we can to get approval from your accreditation organization.

## ***How do I sign up for a class?***

Use the online form at <https://relaytraining.com/relay-tesing-training-courses/request-training-course-infomaion/> to register or contact us at [store@relaytraining.com](mailto:store@relaytraining.com) or 303-250-8257, and we'll contact you.





# VALENCE

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